Journal of Engineering Sciences
Vol 11, Issue 6,June/2020
ISSN NO:0377-9254

DESIGN AND FABRICATION OF HYDRAULIC SCISSOR LIFT

R.Panchamoorthy[1], R.Velappan[2] and P.Balashanmugam[3]
[1]*Assistant Professor, Mechanical Engineering, Annamalai University, India*
[2]*Assistant Professor, Mechanical Engineering, Annamalai University, India*
[3]*Associate Professor, Mechanical Engineering, Annamalai University, India*
[1]*Deputed to Government Polytechnic College, Uthangarai.*
[2]*Deputed to Government Engineering College, Thanjavur*
[3]*Deputed to Central Polytechnic College, Chennai.*

***Abstract*— The paper describes the design as well as analysis of hydraulic scissor lift having two levels. Conventionally a scissor lift (or) jack is used for (maintenance, repair and clean) lifting the vehicle to change the tire, to gain access to go to the underside of the vehicle to lift the body to appreciable height, and many other applications. These systems were performed by having a load carrying capacity of 200kg and a working height of 1m. A Scissor lift is the type platform in a Cris-cross pattern known as Pantograph. The upward motion is achieved by the application of pressure to outside of the lowest set of support elongation the crossing pattern and propelling the work platform vertically. This paper describes the complete study of components (hydraulic cylinder, Scissor arms, spacing shaft and platform), selection of materials and analyzes the dimensions of components along with their sketches with the help of design software. Further fabrication of all the parts and assembly is carried out.**

***Keywords*— actuator, Scissors arms, Angle Plate, Rivets.**

1. INTRODUCTION

A hydraulic scissor lift is a mechanical device used for various applications for lifting of the loads to a height or level. A lift table is defined as a scissor lift used to stack, raise or lower, convey and/or transfer material between two or more elevations. The main objective of the devices used for lifting purposes is to make the table adjusted to a desired height. A scissor lift provides most economic, dependable & versatile methods of lifting loads; it has few moving parts which may only require lubrication. This lift table raises load smoothly to any desired height. The scissor lift can be used in combination with any of applications such as pneumatic, hydraulic, mechanical, etc. Lift tables may incorporate rotating platforms (manual or powered); tilt platforms, etc., as a part of the design. Scissor lift design is used because of its ergonomics as compared to other heavy lifting devices available in the market. The frame is very sturdy & strong enough with an increase in structural integrity. A multiple height scissor lift is made up of two or more leg sets. These types of lifts are used to achieve high travel with the relatively short platform.

Industrial scissor lifts & tilters are used for a wide variety of applications in many industries which include manufacturing, warehousing, schools, grocery distribution, military, hospitals and printing. The scissor lift contains multiple stages of cross bars which can convert a linear displacement between any two points on the series of cross bars into a vertical displacement multiplied by a mechanical advantage factor. This factor depends on the position of points chosen to connect an actuator and the number of cross bar stages. The amount of force required from the actuator is also amplified, and can result in very large forces required to begin lifting even a moderate amount of weight if the actuator is not in an optimal position. Actuator force is not constant, since the load factor decreases as a function of lift height. The load scissors mechanism itself - cylinder and Scissor arms; hence, hardness and stiffness are required.

Types of scissor lifts are as follows

1. Hydraulic Lifts

The hydraulic scissors lift is operated using the fluid pressure that raises the platform via power through the use of pressurized hydraulic oil. Slight speed variation is possible owing to temperature fluctuations that can alter the viscosity of the hydraulic oil.

2. Pneumatic Lifts

The pneumatic lifts are operated using air pressure and they are very efficient because the power supply is carried out by compressing the atmospheric air. Most of the units don't require electricity and thus can be used at any place where the air is available.

3. Mechanical Lifts

The mechanical lifts are extended through a rack and pinion system or power screw, both of which can convert rotational motion. All the electric lifts are mechanical. The benefit of mechanical lift is that the teeth of its gear system prevent from slippage essentially.

II.MATERIAL SELECTION

Selection of the material is the most important factor in designing the system which depends on a component and tasks that the component performs. Different parts of the mechanism take different load and stress because they carry out different functions. Individual approach is necessary to select a material for every part. The detailed study impacts on total efficiency and benefits from it help to decide best properties which can give different materials. Thus, main parts of the design are allocated and features of each and every part are explained separately.

The main interest is made by the Scissor arms of the lift, the greatest part of the loading is shared between them and they are a basic element of the assembly. This part is subjected to a normal force which can cause buckling and shear force cause bending. Thus, there can be bending deformation or breaking of the part. Properties such as strength, hardness, and stiffness are needed. The appropriate material for the purpose is mild steel.

The second basic element is the design of the hydraulic cylinder. According to the system the cylinder is subjected to direct compressive force which leads to the bending and buckling load in the rod and also due to the internal pressure of the fluid, there are circumferential and longitudinal stresses all around the wall thickness, thereby the cylinder must have properties as strength, toughness, ductility and hardness. An appropriate material is mild steel.

The third components are top platform and base support frame. The top platform takes the load caused by a weight of lifting the material. The main needed property here is strength and the selected material is mild steel. The base support frame is subjected to the weight of the load scissors mechanism itself -cylinder and Scissor arms; hence, hardness and stiffness are required. Mild steel is appropriate.

III.COMPONENTS AND DESCRIPTION

It is necessary to evaluate the particular type of forces imposed on components with a view to determining the exact mechanical Properties and necessary material for each equipment. A very brief analysis of each component follows thus:

a) Scissors arms
b) Hydraulic cylinder
c) Top plat form
d) Base plat form
e) Wheels
f) Bearing
g) Hinge Support
h) Angle Plate
i) Washer
j) Nuts & Bolts
k) Rivets

a. Scissors Arms

This component is subjected to buckling load and bending load tending to break or cause bending of the components (shown in figure1). Hence, based on strength, stiffness, plasticity and hardness. A recommended material is stainless steel. There are many different metals that can be made into sheet metal, such as aluminum, brass, copper, steel, tin, nickel and titanium. For decorative uses, some important sheet metals include silver, gold, and platinum (platinum sheet metal is also utilized as a catalyst.)

Fig.1 Scissor Arms

b. Hydraulic Cylinder

A hydraulic jack uses a liquid, which is incompressible, that is forced into a cylinder by a pump plunger. When the plunger moves forward, it pushes the oil through a discharge check valve into the cylinder. The suction valve ball is within the chamber and opens with each draw of the plunger .The discharge valve ball is outside the chamber and opens when the oil is pushed into the cylinder. At this point the suction ball within the chamber is forced shut and oil pressure builds in the cylinder. This component is considered as a strut with both ends pinned as shown in figure 2. It is subjected to direct compressive force which imposes a bending stress which may cause buckling of the component. It is also subjected to internal compressive pressure which generates circumferential and longitudinal stresses all around the wall thickness. Hence necessary material property must include strength, ductility, toughness and hardness. The recommended material is mild steel.

Top Platform:

It is required to design a platform which should serve under heavy load application and withstand high stresses. This component is subjected to the weight of the workman and his equipment, hence strength is required, the frame of the plat form is mild steel and the base is wood.

Fig .2 Hydraulic Cylinder

C.Base platform

This component is subjected to the weight of the top plat form (as shown in figure3) and the scissors arms. It is also responsible for the stability of the whole assembly, therefore strength. Hardness and stiffness are needed mechanical properties. Mild steel is used.

Fig. 3 Base Platform

d. Wheel

In its primitive form, a wheel is a circular block of a hard and durable material at whose center has been bored a circular hole through which is placed an axle bearing about which the wheel rotates when a moment is applied by gravity or torque to the wheel about its axis, thereby making together one of the six simple machines as shown in figure 4. When placed vertically under a load-bearing platform or case, the wheel turning on the horizontal axle makes it possible to transport heavy loads; when placed horizontally, the wheel turning on its vertical axle makes it possible to control the spinning motion used to shape materials.

Fig. 4 Wheel

e. Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts as shown in figure 5. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the

vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Fig. 5 Bearing

f. Hinge Support

Fig .6 Hinge Support

g. Angle Plate

An angle plate is a work holding device used as a fixture in metalworking as shown in figure 7. The angle plate is made from high quality material (generally spheroid cast iron) that has been stabilized to prevent further movement or distortion. Slotted holes or "T" bolt slots are machined into the surfaces to enable the secure attachment or clamping of work pieces to the plate, and also of the plate to the worktable. Angle plates also may be used to hold the work piece square to the table during marking-out operations. Adjustable angle plates are also available for work pieces that need to be inclined, usually towards a milling cutter. Angle plates also may be used to hold the work piece square to the table during marking out operations.

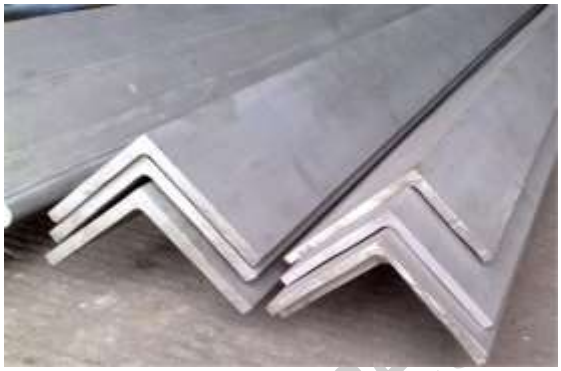

Fig . 7 Angle Plate

h. Washer:

A washer is a thin plate (typically disk-shaped, but sometimes square) with a hole (typically in the middle) that is normally used to distribute the load of a threaded fastener, such as a bolt or nut as shown in figure 8. Other uses are as a spacer, spring (Belleville washer, wave washer), wear pad, preload indicating device, locking device, and to reduce vibration (rubber washer). Washers often have an outer diameter (OD) about twice their inner diameter (ID), but this can vary quite widely.

Fig. 8 Washer

i. Nuts & Bolts

A fastener (Nuts & Bolts) is a hardware device that mechanically joins or affixes two or more objects together as shown in figure 9. In general, fasteners are used to create non- permanent joints; that is, joints that can be removed or dismantled without damaging the joining components. Welding is an example of creating permanent joints. Steel fasteners are usually made of stainless steel, carbon steel, or alloy steel.

Fig. 9 Nuts Bolts

h. Rivets

A rivet is a permanent mechanical fastener. Before being installed, a rivet consists of a smooth cylindrical shaft with a head on one end as shown in figure 10. The end opposite to the head is called the tail. On installation, the rivet is placed in a punched or drilled hole, and the tail is upset, or bucked (i.e., deformed), so that it expands to about 1.5 times the original shaft diameter, holding the rivet in place. In other words, pounding creates a new "head" on the other end by smashing the "tail" material flatter, resulting in a rivet that is roughly a dumbbell shape. To distinguish between the two ends of the rivet, the original head is called the factory head and the deformed end is called the shop head or buck-tail.

Fig. 10 Rivets

IV.ARC WELDING TECHNIQUES

Arc welding is a welding process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals as shown in figure 11. It is a type of welding that uses a welding power supply to create an electric arc between a metal stick ("electrode") and the base material to melt the metals at the point of contact. Arc welders can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes.

The welding area is usually protected by some type of shielding gas, vapor, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles.

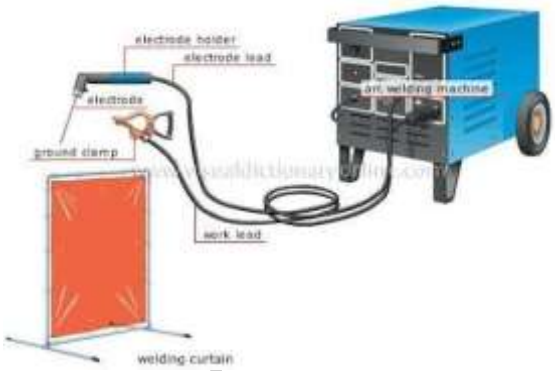

Fig. 11 Arc Welding Machine

a. Working Principle

A hydraulic lift table raises and lowers when hydraulic fluid is forced into or out of the hydraulic cylinder(s). As hydraulic fluid is forced into a cylinder, the cylinder strokes outward forcing the scissor legs apart.

b.Raising the Lift Table:

Since one end of both the inner and outer legs are connected to the base and platform, the platform rises vertically as the scissors legs open. The free end of the scissors legs are fitted with rollers that run in the base. Any time a lift table is raised, it is being supported by a column of fluid. The lift table remains in a raised position because the fluid is held in the cylinder(s) by a simple check valve. A lift table's up speed is a function of the hydraulic pump and the motor that is turning it. The desired up speed and capacity to be lifted determine the amount of work the motor has to do, thus the horsepower required.

c.Lowering the Lift Table:

The lift table is lowered by opening a down valve that allows fluid out of the cylinder at a controlled rate. The down speed of a lift table is a function of controlling how fast the fluid is allowed to leave the cylinder. This is done with a flow control (FC) valve. The FC valve is pressure compensated, which means it regulates the flow to

a predetermined range whether the lift is loaded or empty. These FC valves are fixed rate or non-adjustable and typically the lift table's down speed is matched to lift table's up speed. These types of lifts are used to achieve high travel with relatively short platform. The scissor lift contains multiple stages of cross bars which can convert a linear displacement between any two points on the series of cross bars into a vertical displacement multiplied by a mechanical advantage factor. This factor depends on the position of the points chosen to connect an actuator and the number of cross bar stages. The amount of force required from the actuator is also amplified, and can result in very large forces required to begin lifting even a moderate. Hydraulic Scissor Lift during lifting the heavy loads. Amount of weight if the actuator is not in an optimal position. Actuator force is not constant, since the load factor decreases as a function of lift height. Conventionally a scissor lift or jack is used for lifting a vehicle to change a tire, to gain access to go to the underside of the vehicle, to lift the body to appreciable height, and many other applications also such lifts can be used for various purposes like maintenance and many material handling operations. It can be of mechanical, pneumatic or hydraulic type. The design described in the paper is developed keeping in mind that the lift can be operated by mechanical means by using pantograph so that the overall cost of the scissor lift is reduced. In our case our lift was needed to be designed a portable and also work without consuming any electric power so we decided to use a hydraulic hand pump to power the cylinder Also such design can make the lift more compact and much suitable for medium scale work.

d.Advantages

- Hydraulic lifts are cheaper to install than other elevator types.
- They occupy less space in a building, requiring almost 10% less area for the liftshaft.
- They are highly effective with heavy loads, as the hydraulic power provides a far greater lifting strength.
- There is no need for an overhead machine room. Similarly, overhead structural requirements aren't needed either. The load of the elevator is distributed to load- bearing walls.
- You have the option of using a remote machine room.
- Despite the popularity of the hydraulic elevator system, it does come with its own set of drawbacks.

e.Applications

An "'industrial scissor lift table is a device that employs a scissors mechanism to raise or lower goods and/or persons. Typically lift tables are used to raise large, heavy loads through relatively small distances. Common applications include pallet handling, vehicle loading and work positioning.

- The scissor lift table can raise a forklift so that maintenance to the underneath of the forklift can be performed.
- By employing scissor lift tables in a warehouse, all heavy items can be lifted with ease. You can use it to stack boxes, pallets and other heavymaterials.
- Sheet metal is often stacked. The metal is usually too heavy for employees to try and lift for the stacking process. This is where a scissor lift table can help.
- Distributaries often use scissor lift tables for the lifting of merchandise.
- Scissor lift tables can be used to lift people and those in wheelchairs. By using a lesser capacity scissor lift, you can lift people for outdoor chores such as cleaning gutters and windows. Those who use wheelchairs can use the lift to reach higher levels with less constraint.
- In major cities, you will often see scissor lift tables used as platforms for maintenance and construction.
- Some scissor lift tables are used as weight platforms to weigh machinery and other mechanisms.
- Use the lift as a deck extension during a major renovation or project. Scissor lift tables can help you in any renovation or remodel. It is useful for allowing people to reach higher areas of a building as shown in figure12.

Fig. 12 Final Assembly

CONCLUSION

Hydraulic scissor lift is designed for high load resistance. Scissor lift is easy to use and routine maintenance is not required. Mild steel is selected for the construction of scissor lift as it has greater durability, strength, easy and cheap availability. For the given dimensions the scissor lift can lift a load in the range of 100 to 200 kg up to the height of 3feet.The lift provides plenty of scope for modification for further improvements and operational efficiency.

REFERENCES

[1].M.Kiran Kumar, J.Chandrashekhar, Mahipal Manda, D.vijay Kumar (2016), Design & Analysis of Hydraulic Scissor Lift. *IRJET* Vol.3 page.1647.

[2].Jaydeep M. Bhatt, Milan J. Pandya(2013), Design and Analysis of an Aerial Scissor Lift, *Journal of information, knowledge and research in mechanical engineering,* Vol.02 Page 452.

[3].Georgy Olenin, (2016) Design of hydraulic scissor lifting platform, Saimaa University Of Applied Sciences Lappeenranta, Page no.13-14.

[4].Gaffar G. Momin, Rohan Hatti, Karan Dalvi, Faisal Bargi, Rohit Devare,(2015), Design, Manufacturing & Analysis of Hydraulic Scissor Lift,*IJERGS,* Vol.3 Page 735-738.

[5]. Barsel, R.K., 'Fluid Mechanics', 2nd Edition, John Wiley & Sons, 1998.

[6]. Gupta, R.K., 'Machine Design', 4th Edition, Eurasia Publishing House, Ltd., 2006.

[7]. Franklin Mill, 'Aerial Lift Safety: Operating Requirements' retrieved Online: 21/04/2011.

[8]. Hedge, R.K., 'Mechanical Engineering Science', 3rd EditionJohn Wiley & Sons, 1995

[9]. Khurmi, R.S. and Gupta, R. K., 'Theory of Machines', 2nd Edition, Chaurasia Publishing House, Ltd., 2006.

[10]. Understanding Scissor Lift Deflection, retrieved online at www. Auto quip. Com, 21/04/2011.

[11]. WCB Standards: A324 Forklift Mounted Work Platforms Retrieved Online 21/04/2011.

[12]. Elevating Work Platform, Retrieved online at www. Wikipedia, 21/04/2011.